Seafloor Sediment
Environmental Measurements In Support Of The
High Frequency Sound Interaction In Ocean Sediments

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LONG-TERM GOAL

The project is directed toward the quantification of selected sediment properties crucial to the modeling of high frequency sound interaction in ocean sediments. The effort is two-fold. One part of the research is based on an in situ three-dimensional measurement approach of selected sediment properties (specifically permeability). The second part, the microfabric studies, will provide a better understanding of the sediment pore fluid pathways and porometry leading to the development of microfabric models that describe important sediment properties such as fluid flow characteristics, isotropy and anisotropy, stress-strain behavior, and pore space available for water, gas, and biogenic materials (Bennett et al. 1989a, 1996).

OBJECTIVES

Objectives of the project are to 1) develop and test an in situ permeameter to be used in the full scale DRI field experiment and 2) analyze sediment samples for quantitative microfabric modeling studies. This project is in support of the ONR-DRI High Frequency Sound Interaction Modeling effort for prediction and evaluation of sound interaction in marine sediments. One crucial objective is to collect permeability data in a three dimensional configuration with a sand probe. Richard Bennett (SEAPROBE) will work in cooperation with Dr. Paul Johnson (University of Washington) on the probe design. The University of Washington also will collect in situ wet bulk density/porosity data with a probe developed by Dr. Johnson. These measurements will provide a strong statistical database of in situ sediment properties that are crucial input parameters for high frequency modeling.

An additional thrust is to develop techniques for “undisturbed” sediment sampling of sandy deposits, laboratory processing of these samples for electron and optical microscopy and the study, reconstruction, and quantification of the two and three-dimensional microfabric and porometry (Bennett et al., 1989b). Interstitial organic material will be preserved during sampling which should lead to a better understanding of the interrelationships between the solids (mineral grains) and the indigenous microbiota and organic debris deposited contemporaneously during sedimentation (Baerwald et al. 1991).

APPROACH

The team designing and developing the permeameter probe will draw heavily on earlier work and past experience in geo-probe development (Bennett et al.1990, 1989b). State-of-the-art techniques used by other researcher and engineers will be reviewed and incorporated in the design as require including

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sensor technology, materials, electronics and computer technology. The system will be built by the University of Washington and tested prior to the DRI field exercise.

The microfabric studies will extend the present science and technology used for fine-grained sediments in the collection of "undisturbed" samples, preservation of organic material, and the reconstruction and modeling of the two and three-dimensional fabric and pore fluid pathways (Bennett et al, 1996). The development of new techniques, laboratory analyses and digital image analysis will be a major aspect of the research. This work will be in cooperation with Prof. Kenneth Curry and two graduate student assistants at the Biology Department, University of Southern Mississippi, Hattiesburg, MS, and with Dr. M.H. Hulbert, Resource Dynamics (modeling) under the direction of R. Bennett (SEAPROBE).

WORK COMPLETED

FY-98 was the start-up year and the effort included meeting attendance, planning, coordination with other researchers, and initial development of the experimental design for laboratory work. Preliminary research was conducted on specific technical design aspects of the permeameter to be built by the University of Washington (UW). The research team was established for the microfabric studies. Several technical planning meetings were held. Preliminary embedding tests on a selected sand samples were made for the microfabric work (promising results) to be used in the field and laboratory. Initial study, research and planning was made of the precision grinding techniques to be used in the preparation of the sand samples for electron microscopy and image analysis. Selected software was reviewed for the image analysis of the microfabric.

RESULTS

- Conducted initial embedding of sands for EM studies.
- Initiated evaluation of precision grinding apparatus and techniques.
- Began evaluation of the software requirements for digital image analysis and reconstruction of the two and three-dimensional microfabric of sands.
- Software was reviewed for image analysis of the microfabric.
- Initiated analysis of the permeameter filter requirements for the UW probe.
- Planning and coordination with research team.
- Microfabric research team members were established with USM (Dr. Ken Curry and students) and Resource Dynamics (Dr. M.H. Hulbert).

IMPACT/APPLICATIONS

Acoustic behavior in sediment is complex and reliable predictive capabilities (models, numerical formulations and quantitative estimates) must consider the combined effects of the sediment properties at various scales depending upon the frequency of interest. A deficiency exists in the available in situ sediment properties data bases necessary for the testing and evaluation of high frequency sound interaction models for shallow water coastal sediment types. These studies will provide important input parameters for sediment in coastal areas having direct application to U.S. Naval activities. These studies have application to environmental management activities, understanding of hydrologic processes, and engineering and acoustic problems involving objects placed on and in the seafloor.

TRANSITIONS

The project will provide important environmental data on the sediment physical properties and variability and the microscale characteristics of sandy sedimentary deposit. These data are important to applied problems of interest to the Navy in areas of mine burial, buried mine performance, detection, and environmental assessment.

RELATED PROJECTS (Not Applicable**)**

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